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SHIPYARD ENGINEERING
AND
PLANNING ORGANIZATIONS

Prepared
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Principle research was conducted by Bath Iron Works in cooperation with other shipyards who responded and the questionnaire and other personal contacts."

I N D E X

LIST OF FIGURES

EXECUTIVE SUMMARY

U. S. shipyards have recognized the advantages. of zone-oriented production methods and are using them to some. extent. Some of these shipyards are producing zone-oriented design information to support the production trades using these new methods. The design organizations producing these products, however, are generally based on a functionally oriented philosophy developed to produce system oriented drawings. It follows that improvements in the organization could be made to better serve the concept of providing zone-oriented design products.

This research study analyzes and compares current planning and engineering organizations in both U.S. and foreign shipyards. Based on the results of questionnaires and personal contacts with the shipyards, evaluations were made of the various organizations and their inherent strengths and weaknesses. From these results a model organization was developed which is considered to be more efficient at providing zone-oriented design products directly to the production trades. The proposed model organization combines both engineering and planning in one division under a vice president. This facilitiates integration of both planning and engineering documents in the information provided to the production trades. The model is further characterized by dividing the design process into two distinct

phases each managed by a director reporting to the vice president. The first or functional design develops the design by system and only to the level necessary for approval. The second or product design completes the design by zone for direct use by the production trades. For shipyards desiring to make a change to the model organization, suggestions have been provided for making the transition.

INTRODUCTION

The organization of design and Planning departments in U.S. shipyards has traditionally been a mixture of functionally-oriented and project-oriented philosophies. This mixed pattern was developed while the shipyards used the classic. system-oriented drawings and construction methods. Zone oriented detail drawings and construction methods have since been introduced without the corresponding organizational. changes. While the benefits of zone oriented design products and methods are more readily recognized, the potential benefits of the corresponding organizational structures are less easily grasped, causing a lag in the transition towards an integrated organization and integrated products and processes. This lag in organizational change is further highlighted by the fact that while zone oriented design products and production processes are relatively common among shipyards, improvements in organization. have received significantly less attention. This research study analyzes and makes comparisons of current design and planning organizations in both U.S. and foreign shipyards. From this information, BIW developed a model organization for engineering and planning which is better suited to zone oriented construction. Suggestions have been provided for making the transition to this model organization.

DESCRIPTION OF ORGANIZATIONAL TYPES

Information for this study was gathered from numerous shipyards, both domestic and foreign. The initial contact was made by mailing a questionnaire to prospective shipyards. The questionnaire utilized asked each shipyard to provide information on the following:

1. Their primary type of business
2. Their present methodologies
3. Their present-organizational structure

Upon receipt of the responses, these shipyards were canvased by telephone to ascertain correct understanding and to complete any data omitted.

The information gathered from the questionnaire led us to categorize the various shipyards. This categorization was necessary given the broad difference in shipyard products, capacities and processes.

The shipyards were categorized as follows:

1. Type A Primary business is (has been) the construction of large surface combatants and/or submarines

2. Type B Primary business is (has been) the construction of naval surface combatants

3. Type C Primary business is (has been) the construction of large commercial ships and/or naval non-combatants

4. Type D Primary business is (has been) the construction of small patrol boats. work boats, tug boats, etc. (Both naval and commercial)

5. Type E Primary business is (has been)repair and overhaul work

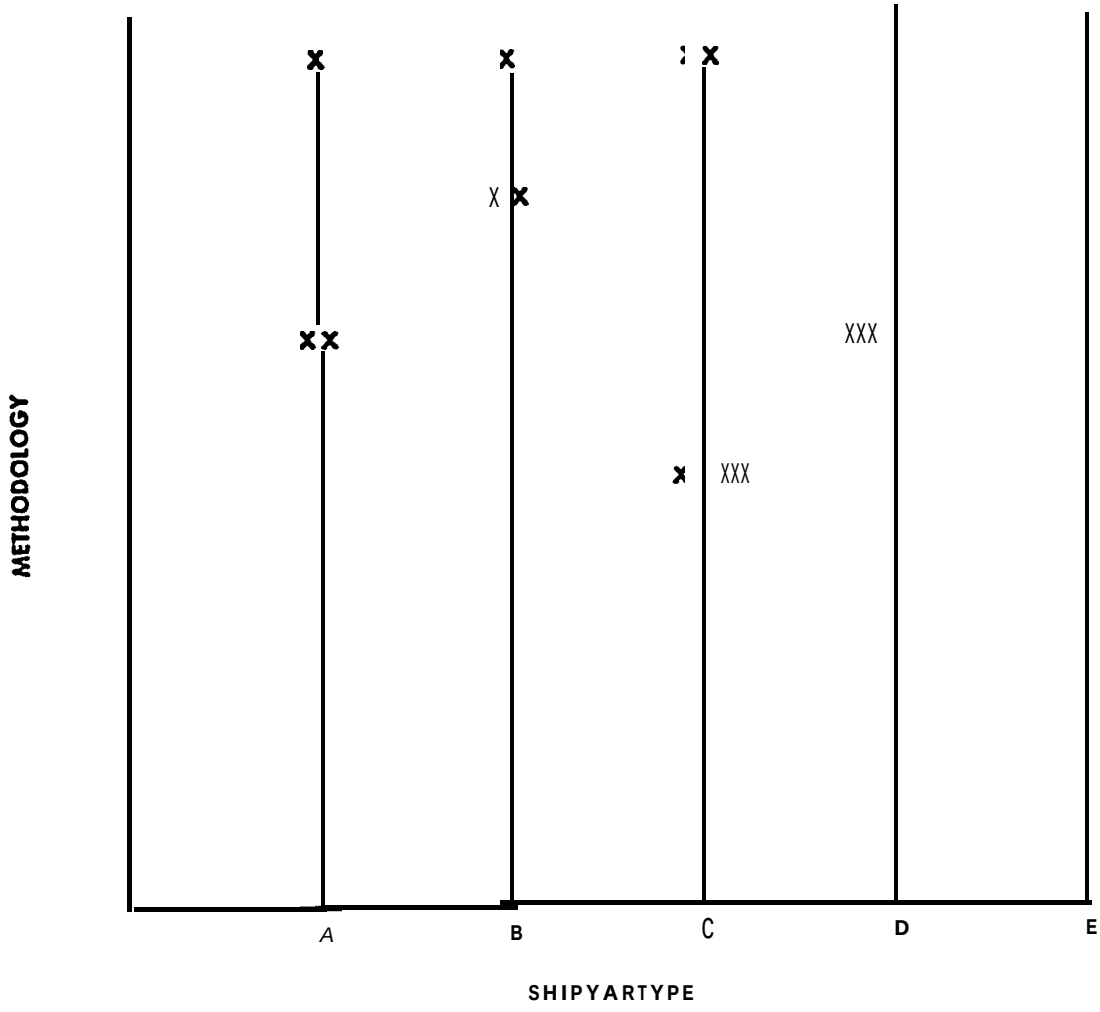
The categorization is by the product size and complexity. Larger size and more complexity generally demand more precise manufacturing and production control processes. Hence, an ideal engineering/ design/planning organization for a Type A yard might not be useful to a Type D or C yard.

Each shipyard was asked to define their present methodology as follows:

1. Traditional by shipboard without Product Work Breakdown Structure (PWBS)
2. Traditional by shipboard system with PWBS
3. Traditional by shipboard system for Outfit. zone oriented for structure and foundations. Simple pre-outfitting .
4. Zone oriented design for outfit and structure without separate fabrication and installation drawings. Simple pre-outfitting
5. Zone oriented design for outfit and structure with separate fabrication and installation drawings. Extensive pre-outfitting
6. Zone oriented design for outfit and structure, complete with planning information for stage and trade.

See Figure 1 for the responses of the shipyards by shipyard category in relation to how they reported their methodology. In general, these responses indicate that the larger shipyards involved in U.S. Navy new construction work have achieved a higher level of zone oriented design and construction methodology. The questionnaire also asked the extent to which pre-outfitting is utilized and the type of drawings which are developed and issued to the respective shipyard trades, i.e., system or zone for outfitting and system or unit (Block) for structural drawings.

FIGURE 1: Shipyard Responses



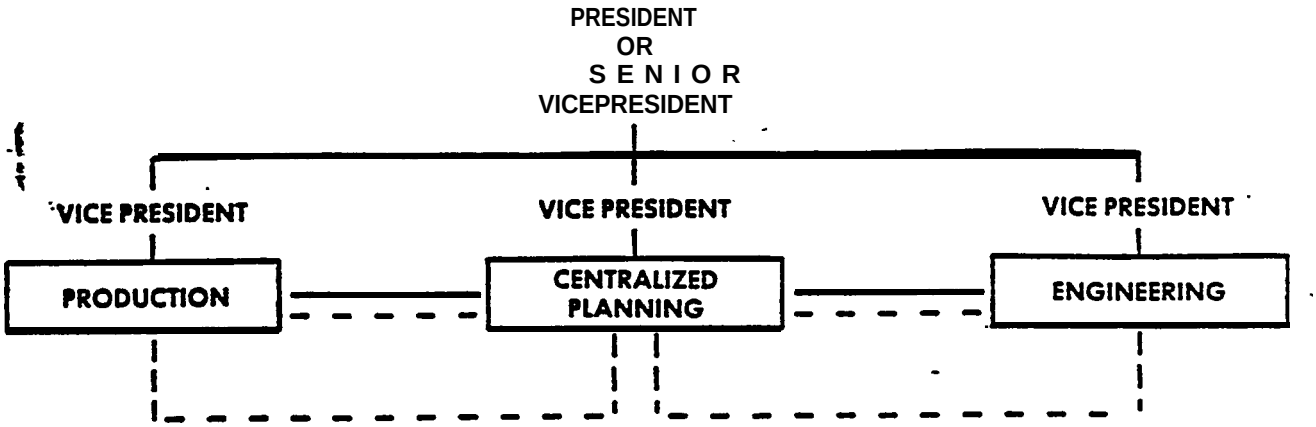
In the organizational charts for their engineering and planning divisions each shipyard was asked to provide, the following concepts were reflected:

1. Separate design and planning organizations, reporting to different V.P.S

2. Separate design and planning organizations, reporting to the same V.P.
3. Planning and design as an integrated organization

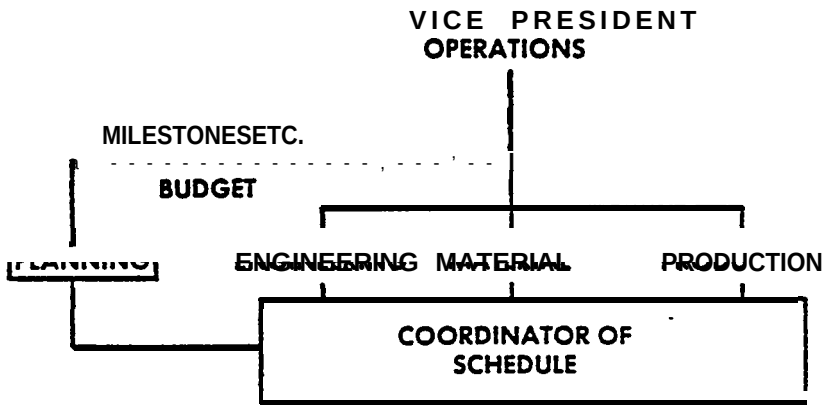
The responses indicated that most of the large shipyards have a centralized planning organization separate from engineering and design. The smaller shipyards tended to combine these functions or as in the case of some of the smallest yards. the planning function is part of the production organization. In the large shipyards, where centralized planning had evolved, many are rethinking this organization and some are now involved in decentralizing" the planning organization. That is, under the new organization, planning will include developing milestones, capacity plans and auditing of other departmental plans. The scheduling, project, and budgeting functions will be de-centralized and become the responsibility of engineering/ design and production. Planning will become a coordinator, but not a detailed planner/scheduler/budgeter. Figures 2, 3 and 4 depict typical organizations for the various categories of shipyards.

FIGURE 2: Organization of Type A and B Shipyards



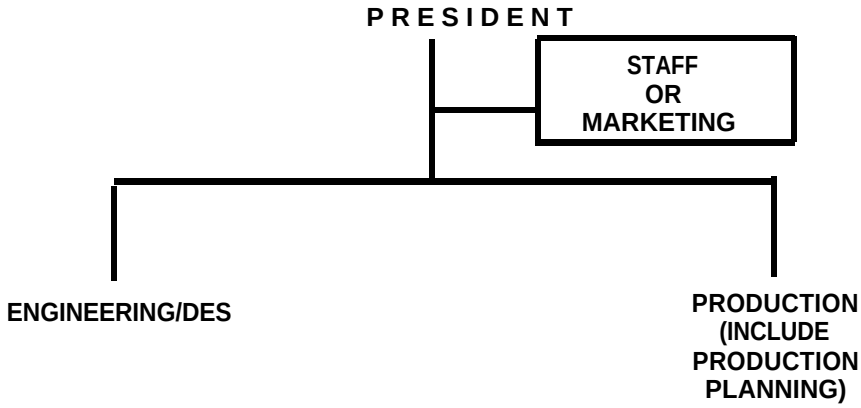
Typical organization for large and moderate size shipyards building naval combatants, shipyard categories types A and B.

FIGURE 3: Organization of Type C Shipyards



Typical smaller shipyard building commercial vessels or naval auxiliaries with de-centralized planning, shipyard category type C.

FIGURE 4: Organization of Type D and E Shipyards.



Typical organization for small shipyards building small vessels and/or overhauls as a primary product, shipyard categories Types D and E.

Traditional organizational theory offers two choices for organizing the business operations of a firm:

(a) A company can organize functionally

(b) Or, a company can organize by product or divison.

Added to this list could be a third option:

(c) A company may utilize a matrix organization to gain a formal organization to manage functionallY organized resources, engineers/designers or planners in producing products.

The scope of this study was limited to the organization of engineering/design/planning divisions. of a shipyard. Therefore, a brief explanation of traditional engineering/design/planning Jorganizations is in order. A traditional engineering department 'that is functionally organized as shown in Figure 5:

FIGURE 5: Traditional Engineering Organization

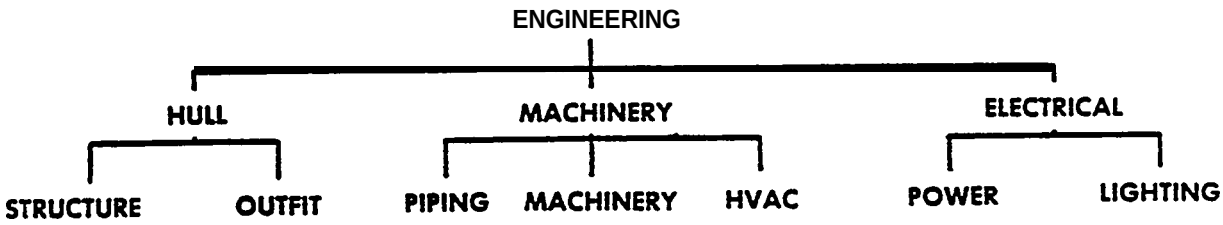
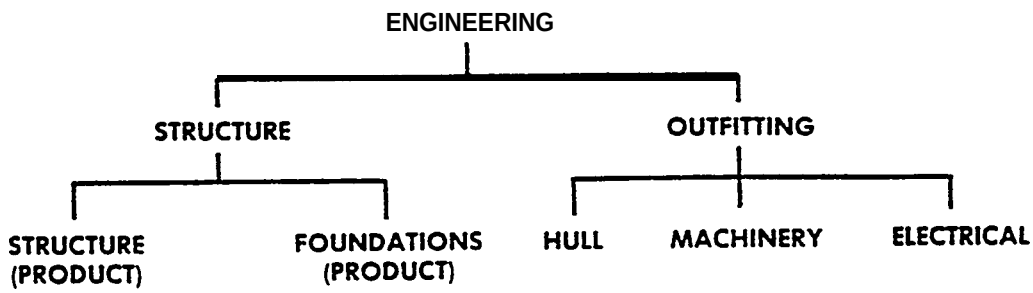


Figure 6 reflects a refined traditional approach used in some shipyards where structure has been separated from outfitting.

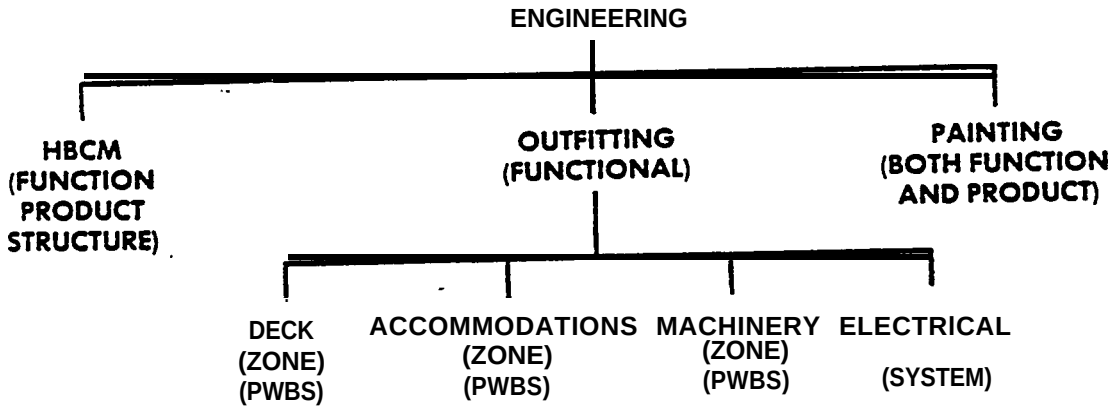
FIGURE 6: Refined Traditional Engineering Organization



In both Figure 5 and 6 the resources, engineers/designers and planners are managed in sections whose responsibilities are functionally related.

In our research. no pure,product organizations were found. The IHOP (Integrated Hull/Outfit/Painting) organization, as defined in numerous Marad NSRP studies and as applied by IHI. is a functional-product hybrid organization. This organization is shown in Figure 7.

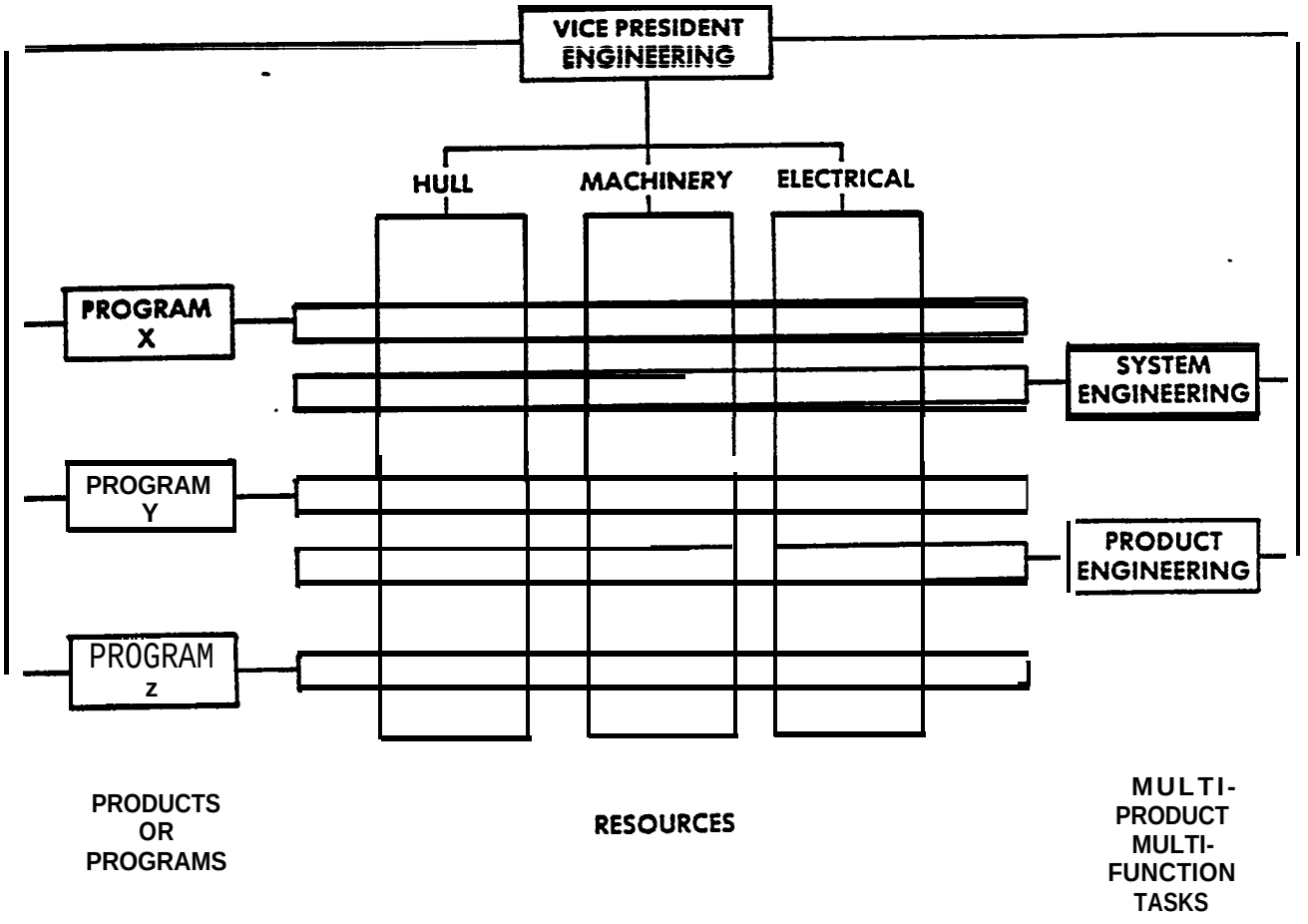
FIGURE 7: IHOP Engineering Organization



In this organization the upper levels are functionally oriented and develop the design. The lower levels are product oriented and supply the products required by the production trades.

A typical matrix organization is functionally organized with an overlay of product managers such as shown in Figure 8.

FIGURE 8: Matrix Engineering Organization



In a matrix organization. the section managers- hull. machinery and electrical, are resource managers. The program managers are

responsible for meeting their product's design schedule. The resource (section) manager's task is to manage the resources (people) to assure that support of all programs (products), changes (systems engineers) and production input is accomplished on schedule and on the targeted budget or below. Research of shipyard organizations has shown that the matrix organization is very popular for those shipyards doing U.S. Navy work. These yards have made an effort to develop their organizations to suit the report generation required by the customer.

ASSESSMENT OF ORGANIZATIONAL TYPES

GENERAL ORGANIZATIONAL TYPES

Functional Organizations

The functionally oriented design organization is one in which the design groups are structured to align primarily with the shipboard systems. Typical design groups in a functional organization are Hull, Electrical, Mechanical and Combat systems.

This type of structure tends to promote a high level of technical expertise within a particular discipline since the people within the group are of the same discipline. This structure provides a working atmosphere where the exchange of technical information is encouraged and easy.

Product Organizations

A product oriented design organization is one in which the design groups are structured to match the physical structure of the product. That is, while a functionally oriented design organization is structured to align the design groups with the shipboard systems. the product oriented organization is structured to align the design groups to some physical portion of the product. This breakdown is, for shipbuilding, generally consistent with the “zone” breakdown of the ship.

The product oriented design organization tends to promote interaction (coordination) between disciplines during the initial design phases, and has the additional benefit of permitting timely resolution of problems and the exchange of inter-discipline data.

The time to react to production problems has the potential of being decreased in this type of organization, since all of the required expertise is under the control of one manager. Problems found in production can also be quickly routed to the appropriate design group. since the design organization is aligned with the physical product.

The product oriented organization is generally more capable of controlling project costs and schedules as the work is being accomplished in line with the way the budgets are handled.

The lines of authority to the decision makers are also shorter in a product oriented design organization and, therefore, more conducive to faster resolution of problems.

Matrix Organizations

A matrix organization is a combination (mixture) structured such that certain functions are performed under a functional organization structure while others are performed on a product basis. There is an infinite variety of matrix organizational types based on the degree of mix between functional and product oriented functions.

The matrix organization attempts to take advantage of the benefits of both the functional and product oriented organizations.

EVALUATION FACTORS

One of the most important factors to consider when dealing with organizational structure is the product that the organization is being structured to produce. For this study, shipyards were classified as one of five types based on their primary product. It became evident-that most of the yards surveyed were organized along traditional (functional) lines with some modification toward a product type organization. This trend appears to be independent of the type of product being produced. The advantages of a product centered organizational structure seems to be recognized by most of the yards interviewed. Given the right circumstances, the yards would reorganize towards some sort of product structure.

It became evident during this study that D and E type shipyards are presented with a unique set of problems if they consider a product based organization structure. These problems stem from the product's type and size. A wood or fiberglass hull does not lend itself well to unit construction practices however, outfitting can still be accomplished based on some sort of a product structure. As for the overhaul yards, the problems are centered around the fact that they are dealing

with a ship which was probably constructed using system drawings. For a repair yard to Control work on a zone basis, all of the design documentation necessary for the overhaul must be converted to zone drawings. This task is

BASIC ORGANIZATION STRENGTHS AND WEAKNESSES

Centralized Planning

The results of the survey and personal contacts showed that the basic function of most centralized planning organization is: (1) package and restructure the design work for production, (2) control the manning budgets and (3) schedule the work for all functional areas of the company. Other functions of the planning organization are long range planning and overall yard capacity planning. It appears that the centralized planning organization function of packaging the work for production grew out of necessity. since the design had to be restructured in order for the product to be produced. It is not a very efficient way to produce a design, but there is little choice unless the design products are changed. The budgeting and scheduling functions are ones that have been traditionally done by a centralized planning organization for business reasons.

Decentralized Planning

A move towards a product oriented design organization and design product eliminates the need to restructure the design. thereby eliminating one function of a centralized planning group. Decentralization of the responsibility for schedules means that each organization (Design, Production, Materials. etc.) would be responsible for producing and maintaining their own schedules. These schedules would be consistent with the master schedules maintained by a small central planning function. The same is true for the budgeting function, with each group responsible for their own budgets with the overall (department level) budgets. controlled by the finance department.

The advantages of decentralized planning are: (1) Making each department responsible for producing and adhering to their own schedule, fostering a sense of ownership and a better performance than if the schedule is imposed by a separate group. (2) The same is true for decentralizing the budgeting with the added benefit that a department can allocate the available budget as necessary to accomplish the job.

Functionally (System) Oriented Design

The functionally oriented design organization is the traditional structure for the shipbuilding industry. With this type of organization, the design products tend to be

functionally (system) oriented and not consistent with the production process. Although it is possible to produce a product oriented design in a functionally organized design organization, it is more common that the design will be system oriented and not production friendly. This type of design tends to separate the design and production groups since very few of the design products can be used directly by production who use product oriented methodologies.

Product Oriented Design

Product oriented design organizations are the way most shipyards are headed. This type of structure produces a design that is producible and consistent with the production process. This type of organization tends to cause redundancies in some cases since each design group requires expertise in all of the design disciplines. The advantages are in the direct support of production. Since the design is being used directly by the production department, there is no buffer between the designer and the production trades. Communications are enhanced, leading to faster resolution of problems and a better design.

MODEL ORGANIZATION

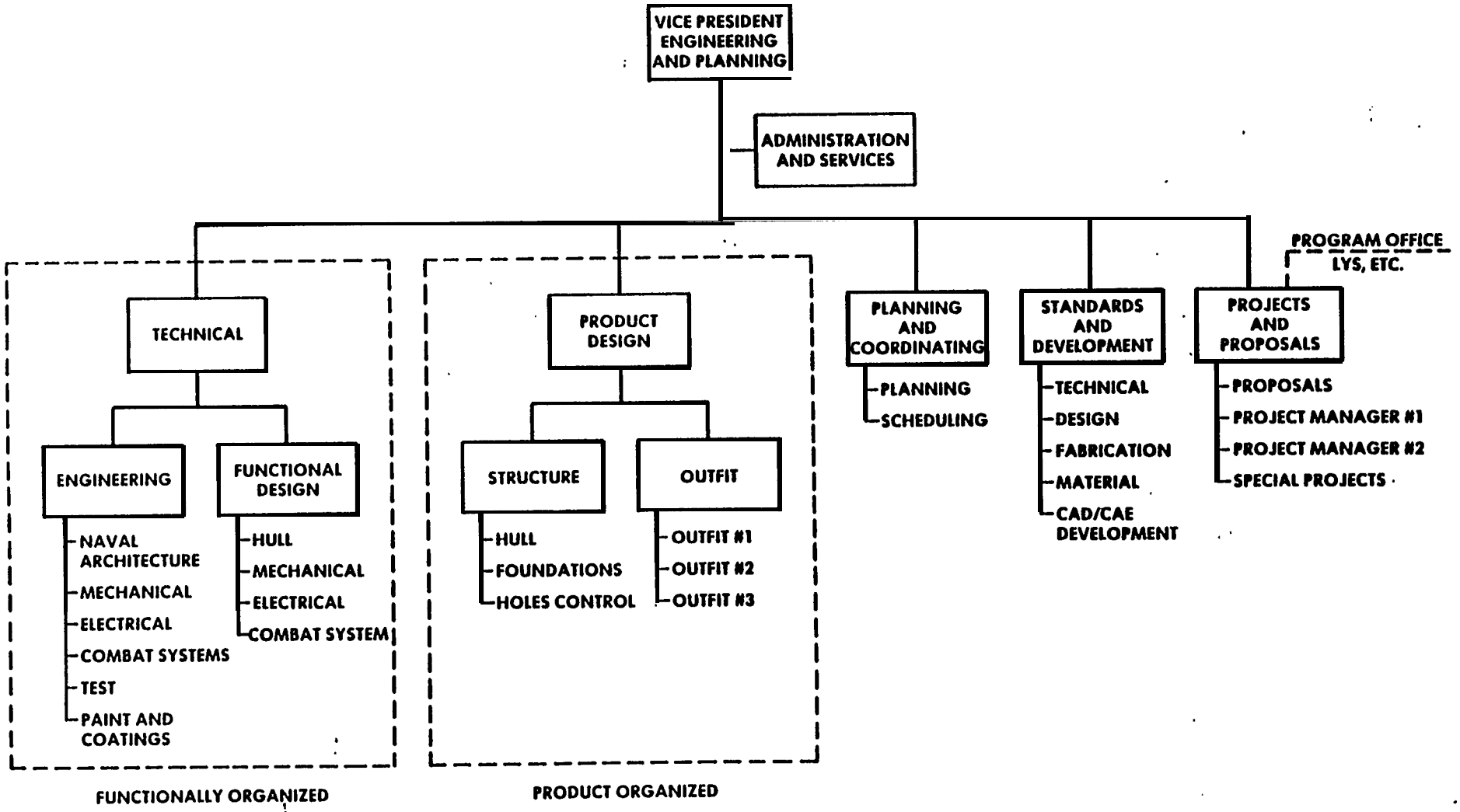
Proposed Organization Chart

To develop an organizational chart, it is useful to define the product that the organization must produce. It is obvious that the proposed engineering and planning organization must produce the drawings and schedules that the production trades need to build the ship. For the purpose of this study, it was assumed that the production trades in the shipyard have adopted modern zone outfitting concepts and will be installing a major portion of the outfit in the structural units prior to erection. Therefore, the information prepared by the engineering and planning departments must be tailored to suit the unit or zone, that is, product oriented. On the other hand. the design must be developed by systems to ensure that each system is complete and workable. It is necessary therefore that engineering and planning develop two distinct designs, one functionally or system oriented and the other product oriented.

A basic model organization was developed to support this two design concept and is shown as Figure 9. It was considered that a Type A shipyard was too specialized and therefore a Type B was chosen. As a Type B yard produces a product requiring a large complex organization, other types of

FIGURE 9

Combined Engineering & Planning Organization



shipyards could use simplified versions of the base organization. In the present market, the Type B shipyard would be producing cruisers, destroyers or frigates and the .U.S. Navy would be the only customer.

For the organization shown, it is assumed that the design would start with a U.S. Navy'Request for a Proposal (RFP) which would include the contract design. A proposal team would be formed under the Director of Projects and Proposals and headed up by a proposal manager who would become the Program Manager when the contract is awarded. His team would be made up of personnel from Planning, Technical. Product Design and, if required. from the Standards group. This team would produce the schedule, build plan and unit definition, as well as the written technical material for the proposal. After the proposal effort, team members would return to their respective groups to work on the design. This would provide a *core* group within each section that would be knowledgeable of what was in the proposal.

After the contract is awarded. the design would start in the technical group. The design would be developed by function or by system. Thus a piping system, such as fresh water, would be developed as a system to the level of sized diagramatics. To prepare the design to this level of detail, the Technical Department has been functionally organized and their product is the design complete with necessary

approvals. Except for the level of detail, the design at this stage is very similar to what has been traditionally furnished to the production trades for building the. ship. As the functional design is being developed, the planning group will be developing the final build plan and establishing the schedule for erection installation and assembly.

With the use of extensive preoutfitting. the traditional functional design has to be changed to a product design to support the production trades. In the proposed model organization, this function will be performed by the Product Design Department within engineering and planning. Within this department, the structure group will provide the production trades with structural work packages which have been tailored to their specific requirement both as to the level of detail and the sequencing of work. Where foundations are to be built into the units, these will be included in the proper work packages. The holes control group. by controlling the interface between zones. will control interference between zones. The outfitting groups will be responsible for controlling interference within the zones.

The outfitting group will provide production trades with outfitting work packages which have been tailored to the outfitting trades specific requirements. These will include. the stage at which the work will be accomplished for the most efficient installation. To provide this information most efficiently, the Outfit group has been product organized and

divided into an appropriate number of sections to develop the work packages for the ship. As each of these sections will require capability in electrical, mechanical and hull outfit to develop the work packages for their assigned zones, they have been labeled as Outfit #l, #2 and #3 rather than hull, mechanical and electrical. It is assumed that each section will have adequate capability in each discipline to provide the design and planning information to the production trades. It is also assumed that the design section with the most expertise in a given field would be assigned the zones with an emphasis in that field.

It is intended that this organization be kept flexible with a free interchange of communication. and where prudent, an interchange of personnel. To provide complete work. packages.to the production trades, Planning personnel would be assigned to the structural or outfitting groups as required. It is also assumed that designers and engineers can be assigned wherever the work load requires.

Detailed Responsibilities

To specifically define the responsibilities within the various sections of the organization chart, a table of Generic Products of Ship Design was developed as shown on Figure 10. For each generic product on the table, responsibility was assigned to a specific group on the

FIGURE 10

Generic Products of a Ship Design

and

Construction Effort

STAGS	PRODUCT OR FUNCTION	Responsibulty
PRIORTOCONTRACT AWARD	l STRATEGIC PLANNING l DESIGN, PLANNING AND *CONSTRUCTION* STANDARDS	PLANNTNG STANDARDS AND DEVELOPMENT
BASIC OR CONTRACT DESIGN PROPOSAL DEVELOPMENT	l PRODUT WORK BREAKDOWN STRUCTURE l BUILD PLAN l DESIGN SCHEDULE l DRAWING UST (PRELIM) l MAJOR MILESTONE SCHEDULE l MASTER CONSTRUCT10N SCHEDULE l PRODUQUITY REVIEWS l LONG LEAD MATERIAL SCHEDULE (MEUM) l PREUMINARY BUDGETS l PURCHASE SPECIFICATIONS (PRELIM) l PREUM UNIT WEIGHT DETERMINATIONS l CONTRACT GUIDANCE DRAWINGS	PERFORMED BY A PROPOSAL TEAM UNDER PROJECTS AND PROPOSALS. THE RASIC TEAM WOULD BE SUPPLEMEMED AS REQUIRED FROM THE OTHER ENGINEERING AND PLNNING GROUPS
FUNCTIONAL DESIGN	l *KEY DRAWINGSMIAGRAME* l *JONG* LEAD MATERIAL SCHEDULE • **STRENGTH & WEIGHT CALCULATIONS** l DEFINTION OF HULL FORM l DRAWING LIST l DETAILED DESIGN SCHEDULE l PURCHASE SPECIFICATIONS l START CAD DATABASE DEVELOPMENT l DETAILED MANHOUR BUDGETS BY DEPARTMENT l MATERIAL ORDERING *SCHEOULE* l PROCUREMENT MTERIAL. LISTS l PRODUCCIBILITY REVIEWS l UNIT HULL CONSTRUCTION PLAN l UNIT CONSTRUCTION SCHEDULE l REFINEO PWRS . DEFINITION OF SHIP ACCESS OPENINGS	*'DESIGN DEVELOPMENT* PLANNING WITH INPUT FROM ENGINEERING NAVAL ARCHITECTURE NAVAL ARCHITECWRE ADMINISTRATION INPUT FROM PROPOSAL PLANNING - Scheduling DESIGN DEVELOPMENT - H M E & C DESIGN DEVELOPMENT - H M E & E FINANCE - ADMINSTRATION FOR ENGINEERING AND MANNING *PLANNING SCHEDULING/MATERIAL* DESIGN DEVELOPMENT H M E & C DESIGN DEVELOPMENT/PRODUCTION DESIGN DEVELOPMENT - HULL PLANNING - SCHEDULING PLANNING HOLES CONTROL
ZONE (OR TRANSITION) DESIGN	l STRUCTURAL DRAWINGS BY UNIT l FOUNDATION DRAWINGS l OUIFIT COMPOSITE DRAWINGS l UPDATED MATERIAL AVAILABILITY l STEEL LIST BY UNIT l REFINED CONSTRUCTION SCHEDULES l REFINED MANHOUR BUDGETS l PRODUCIBILITY REVIEWS l ACCESS AND STAGING PLAN . CAD DATABASE DEVELOPMENT	DESIGN STRUCIURE (HULL) DESIGN STRUCTURE (FOUNDATIONj DESIGN OUTFIT PUNNING WITH INPUT FROM DESIGN DESIGN STRUCTIURE (HULL) PLANNING ADMINSTRATION (ENGINEERING AND MANNING ONLY) DESIGN, DESIGN DEVELOPMENT/PRODICTION PLANING AND HOLES CONTROL DESIGN DEVELOPMENT

FIGURE 10(cont'd)

Generic Products of a Ship Design

and

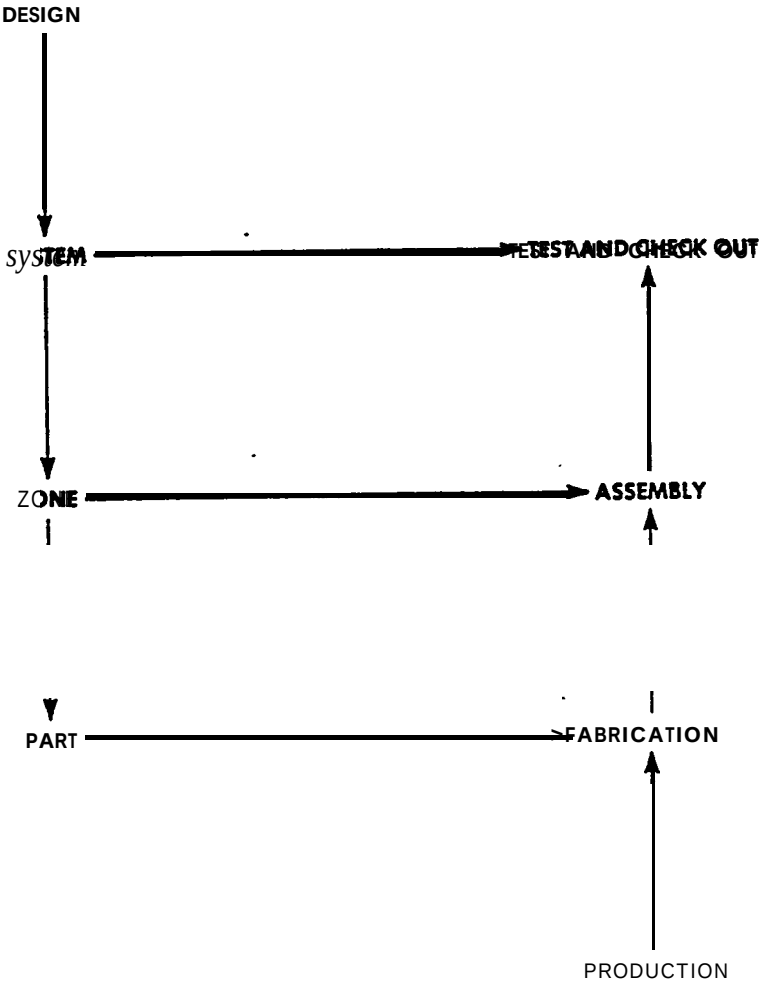
Construction Effort

STAGS	PRODUCT OR FUNCTION	RESPONSIBIUIY
PRODUCTIONDESIGN	● MOCK AND JIG CONFIGURATIONS ● UNIT HANDLING PLAN ● STRUCTURAL FABRICATION AND ASSEMBLY DRAWINGS ●LOFTING . OUTFIT FABRICATION AND INSTALLATION DRAWINGS ● DEFINITION OF MATERIAL GROUPINGS (PALLETS) . STAGE AND TRADE DEFINITIONS ● REFINED MANHOUR BUDGETS ● REFINED CONSTRUCTION SCHEDULES ● REFINED MATERIAl ORDERING SCHEDULES . PRODUCIBILITY REVIEWS ● WORK INSTRUCTIONS FOR PRODUCTION ● CAD DATBASE DEVELOPMENT (PROSUCTION) ● INSTALLATION MATERIAL LISTS ● MATERIAL PROCUREMENT	NAVAL ARCHITECTURE NAVAL ARCIITECTURE DESIGN STRUCTURE (HUILL) DESIGN STRUCTURE(HULL) DESIGN OUTFIT DESIGN OUTFIT/STRUCTURE HULL DESIGN OUTFIT/STRUCTURE FINANCE ADMINISTRATION FOR DIVISION PLANNING PLANNING WETH INPUT FROM DESIGN DESIGW/PROOUCTION DESIGN WITH PRODUCTION INPUT DESIGN DESIGN - OUTFIT MATERIAL DEPARTMENT WETH INPUT FROM DESIGN
PRODUCTION CONTROL	● FACILITIES PLANNING AND SCHEDULING . SHOP MANPOWER PLANNING c STRUCTURAL UNIT MOVE COORDINATION ● MATERIAL REQUISITIONING FROM INVENTORY . ACTIVATEON AND TEST SCHEDULES ● DETAILED SHOP AND 'ONBOARD' SCHEDULES c DRYDOCX SCHEOUIES ● STAGING PLAN (DETAILED) c GENERAL MATERIAL SCHEDULING (FOR PROCUREMENT) ● PROVIDE TECHNICAL ASSISTANCE TO PRODUCTION ● DESIGN/ENGINEERING LIAISON ● MATERIAL PROCUREMENT	PRODUCTON ENGINEERING/PLANNING PRODUCTION PLANNING WITH INPUT FROM NAVAL ARCHITECTURE PRODCTION MATERIAL AU ENGINEERING AND PLANNING DESIGN . STRUCTURE AND OUTFIT MATERIAL DEPARTMENT

organization chart. While this was done somewhat arbitrarily for the study, it should be remembered that in actual practice, the organization should be extremely flexible, and product responsibility shifted to suit the capability. Basically, the functional groups (i.e. technical) should be responsible for the functional design including all approvals by owner and regulatory bodies. The product groups (i.e. Product Design) are responsible for the products required by the production department for start of fabrication. It should be noted that final production requires the output from both functional as well as product- design. As shown on Figure 11. the fabrication process requires detailed output from the product design, the assembly process requires the output at the zone level. while the final test and check out requires the output at the system level. It should be recognized however that for zone production. earlY stages of testing can be completed on the unit at zone level.

FIGURE 11

Design & Production Process



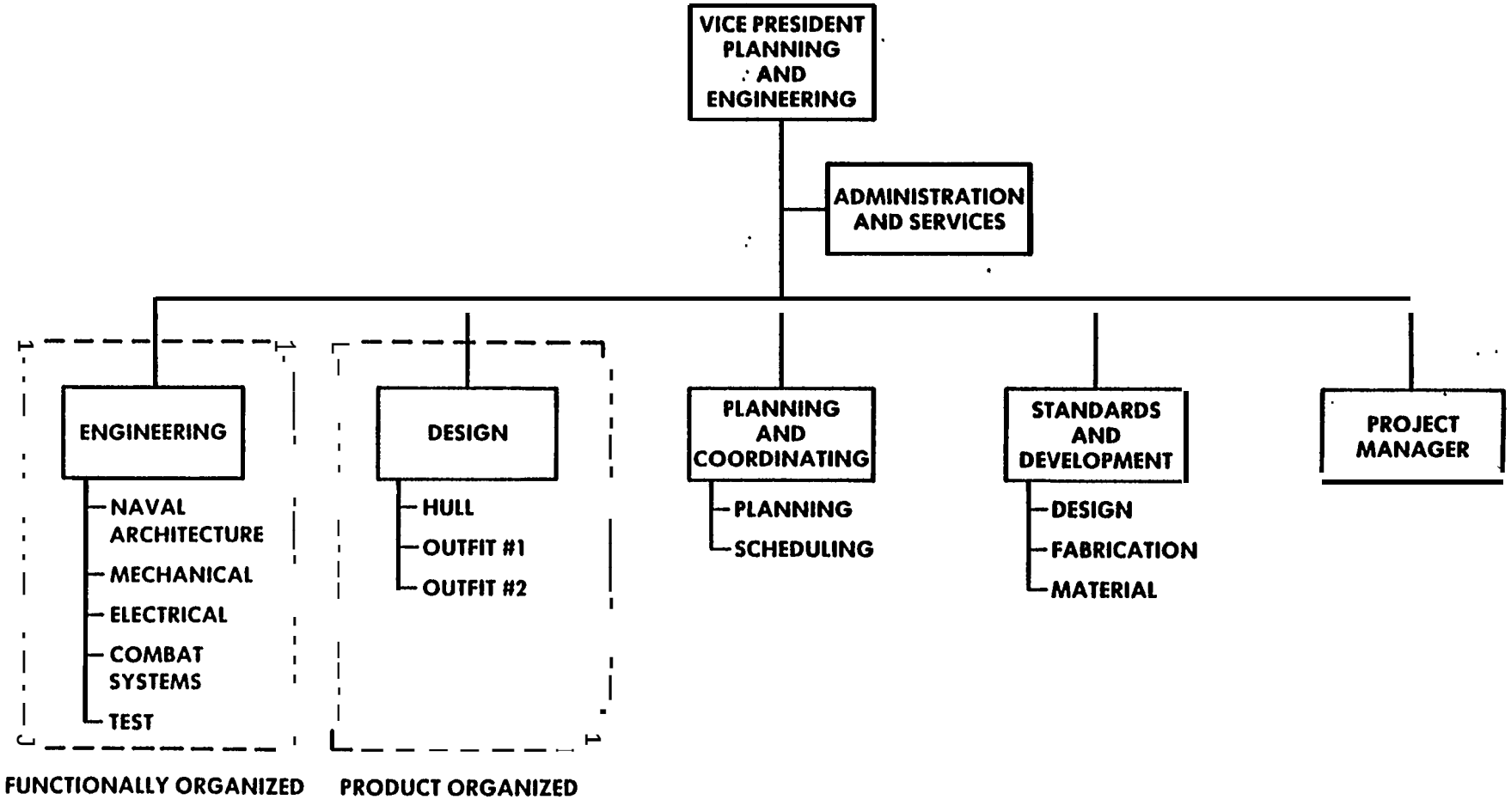
Variations of the Organization Chart

It is obvious that the model organization chart proposed above for a large shipyard building naval combatant ships would not be well suited for a yard whose primary product is overhaul work or for a yard building small naval combatants or naval auxiliaries. To address these other

markets, variations on the basic model organization were prepared. These are shown in Figure 12 and 13. For overhaul work, the basic organization divided unto ‘functional and product groups has been retained, however, in a much simpler form. For overhaul work. the Planning function becomes mote important than engineering and therefore requires relatively a much larger staff. In fact, the engineering *group* could be reduced to a supervisor and several engineers. They would be responsible for providing system diagramatics and obtaining required approvals. The design group would have to be somewhat larger as they would develop the work packages in conjunction with the planning group. The planning group would probably take the lead for the overhaul and develop required schedules as well as the production plan. Again it is intended that the organization be kept flexible. Transfer of personnel should occur as the work load requires. In the early stages a designer might work in engineering developing system diagramatics. When the major work load shifts to design, the engineers may be transferred to the design group to develop products for production.

FIGURE 12

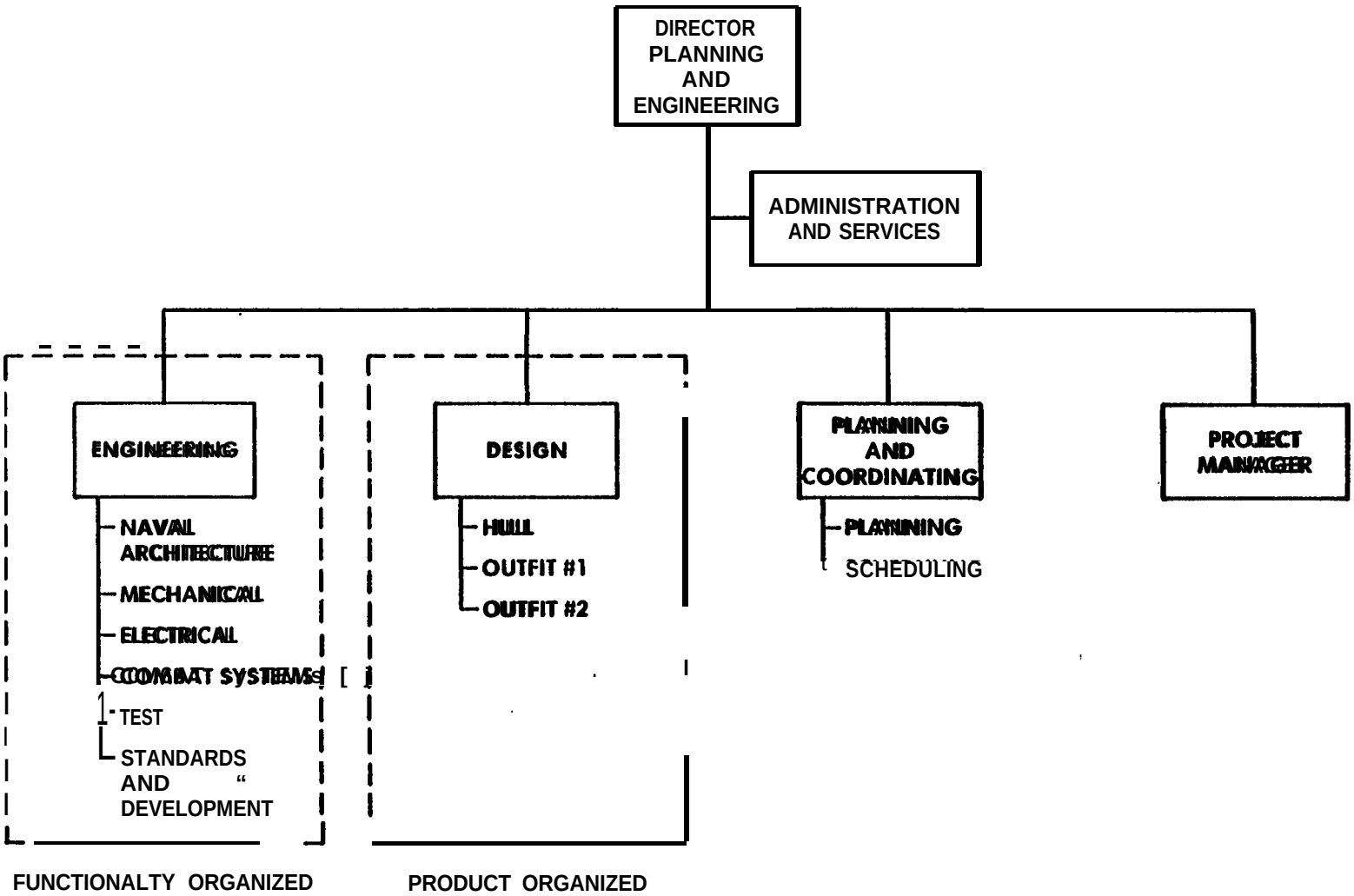
Planning Organization for Overhaul



FLGURE 13

Engineering & Planning Organization

for small Shipyard



For the small shipyard, the basic organization has been further reduced and simplified. Although the organization looks similar to the overhaul chart. and in fact, would probably be about the same size, the primary responsibility for the product is with engineering not planning. This organization is intended to be a small version of the basic chart and the responsibilities would be similar. The only significant change was to include the standards group in engineering. It was considered that standards are necessary and important for the small yard: however. not as important as in the larger yards.

A separate organization chart was not prepared for a shipyard performing nuclear work as it is considered that the basic organization could be the same as for navy surface combatants. It is recognized that a separate functionally organized group would probably be formed which would report to its own vice president. The group would be responsible for the functional design of the nuclear areas only. Product design of these areas should remain the responsibility of the product design group in engineering. This will avoid giving conflicting information to the production trades.

Problem Areas

There are many problems associated with developing and maintaining a stable engineering and design organization in the U. S. today. The major problem is the cyclic nature of

the market and the fact that the U.S. Navy is the only. customer. A lead ship design for a major U.S. Navy construction program requires a very large design and engineering effort while the follow ships require only a small fraction of this effort for continued design support. With lead ship design occurring at five to ten year intervals in any given market, it is not possible to maintain the large organization between lead ships. The alternatives appear to be to either diversify into other markets or utilize the services of a design agent. To diversify into other navy markets might involve the production trades in several multi-ship programs at the same time. This alternative, therefore, is only available to very large ship yards. The medium size and smaller yards are forced to utilize the services of a design agent. For a design agent to produce a complete design, the shipyard would have to educate the design agent to produce the specific products in the format required by their shipyard. This" can be costly in both time and money. A compromise solution is to have the design agent develop the functional design and the shipyard develop transition and zone design. In this manner the design agent does what it is most familiar with i.e., functional design, and the shipyard engineering and design develops the specific product required for their shipyard.

TRANSITION

To execute the proposed organizational change. two methods were identified: revolutionary and evolutionary The appropriate method chosen by a shipyard would be influenced by only one factor, backlog.

A revolutionary change is desirable when a company is experiencing a lull in work. Typically when a work lull occurs, the total yard workforce is low. By reorganizing at this point, fewer personnel are impacted and there is little or no impact on current work. Once this company begins a new contract, employees would be hired into the new organization and its methods.

If a company has a steady backlog, a revolutionary change would not be appropriate. An abrupt change would cause major impact to current work, changing the way documentation is produced, and drawing resistance from employees.

TO accomplish an evolutionary change. several intermediate steps were identified that would ease the impact on design documentation development. Independent of each other, the design and planning departments must reorganize functionally to facilitate future common alignment.

The-design department should split functionally into structural design and outfit design departments. The structural department should include structural design. steel lift and lofting. With the introduction of CAD systems. the latter two functions have become more design oriented than production oriented. The outfit department should retain the hull outfit, electrical and mechanical groups, as separate functional entities.

The planning department should reorganize functionally. This reorganization must facilitate the eventual merging or alignment of planning with engineering in accordance with the model organization. By decentralizing much of the project planning work. the design would include the planning. documentation.

The final phase in the evolutionary. transition process is the reorganization of the outfit design groups from functional to product orientation, and the incorporation of the Planning department into the engineering and design groups. Once the outfit design groups are organized by product, planning-work can be done during the design stage. This would be possible. since a design group is responsible for a zone in its entirety. Previously design groups were functionally organized, making it unpractical for the planning work to be done at the design level.

Any organizational change results in people feeling threatened: meeting change with resistance, whether it is an evolutionary or revolutionary transition. Management can minimize this resistance by instituting an education/training program and providing complete information. Encouraging employee involvement in planning for the change, and listening to the employees concerns will also help to alliviate resistance to the organizational changes.

Top management must be in agreement to their commitment to develop zone oriented documentation which includes planning information (stage and trade). The managers of departments that will be directly affected by the change will probably pose the greatest opposition. Many will see the changes as a reflection on the way their departments or sections were run. Top management must begin at this level with an education program to let people know the goals and reasons for the change. By listening, to their reactions, concerns and questions, top management will better understand lower level management's problems and be able to solve them using the information gained,

To dispel fear at the worker level, whether the transition is revolutionary or evolutionary, training and education are also required, as well as listening to their complaints. Acceptance of change should occur more readily

when" there is an understanding of the reasons for change and employees are given the opportunity to help determine how the new system work will work.

By providing the appropriate education, obtaining employee feedback, and undergoing. the transition at a pace that is dependent upon backlog. the reorganization can be accomplished with a minimum of resistance and morale loss.

CONCLUSIONS AND RECOMMENDATIONS

Every change an organization undergoes will ultimately result in the need for further changes. The change this research project studied was how engineering and planning departments could be reorganized to produce the swtem drawings and. the detailed zone drawings required by production. Many shipyards in the U.S. were contacted to discuss their methodologies and how their organization is arranged to produce their documentation.

Three types of organizations were found to exist; Functional, Product, and Matrix. The strengths and weaknesses of each type have already been discussed in this paper. The project group's optimum organization consists of a functionally oriented technical department, a product oriented design department and a decentralized planning organization.

A functionally oriented technical department would provide the following benefits:

- Since the initial design of a ship is and must be developed by system, this department is involved in the development of the design or it is performed under their cognizance by a design agent.

- Provides input into the detailed design as required.

- Provides support to the waterfront during ship activation since that is performed by function.

- Maintains technical expertise within each discipline.

A product oriented design department would provide the following:

- Create design documentation that has a one-to-one correlation to the production products, both outfit and structure.

- Promote a greater interaction between the outfit design disciplines.

- Reduce the time necessary to resolve interference problems within a particular zone since the problem is within a single design group.

- Problems found in production can quickly be routed to the appropriate design group.

- Creates the potential for better control of project' costs and schedules as the work conforms with the way budgets are handled.

- Eliminate the need for a large centralized planning group-since all the documentation for a zone is developed by a single group greatly reducing the-need to collate information across design disciplines.

A decentralized planning department would provide the following:

- Work such as material staging, scheduling of drawings previously done by a centralized planning group would now be performed by the engineering department.

- Material staging for both outfit and structure could be done during the design phase and worked into the documentation.

- Since the information for a particular zone is consolidated on certain drawings, less people will be required to coordinate this data.

The project group offers the following recommendations in attaining the model organization:

- Top management support of the change is required.

- A new methods education/training program for employees should be implemented.

- The timing and speed of the reorganization should minimize the impact on current work.

BIBLIOGRAPHY

u.s. Department of Transportation. Mritime Administration. The National Shipbuilding Research Program. Paper presented by Thomas Lamb, "Engineering for Ship Production." Hampton Roads, Virginia, 1986.

U.S. Department of Transportation. Maritime Administration. The" National Shipbuilding Research Program, IHI Technology Transfer at Avondale Shimsrards, Inc., Vol. I. Manufacturing Technology for Shipbuiding: planning and Scheduling. Ann Arbor, MI.: Research Information and Publication Service, MSRP 0137, 1982.

U.S. Department of Transportation. Naritime Administration. The National Shipbuilding Research Program, IHI Technology Transfer at Avondale Shipyards. Inc., Vol. II, Manufacturing Technology for Shipbuilding: Design Engineering for Zone Outfitting. Ann Arbor, MI.: Research Information and Publication Service, NSRP 0138, 1982.

U.S. Department of Transportation. Haritime Administration. The National Shipbuilding Research Program, IHI Technology Transfer at Avondale Shipyards, Inc.. Vol. III, Manufacturing Technology for Shipbuilding: Mold Loft, Production Control, Accuracy Control. Ann Arbor, MI.: Research Information" and Publication Service, NSRP 0139, 1982.

U.S. Department of Transportation. Maritime Administration. The National Shipbuilding Research Program, IHI Technology Transfer at Avondale Shipyards, Inc., Vol. IV, Manufacturing Technology for Shipbuilding: Process Lanes and Design Engineering for Zone Outfitting. Ann Arbor, MI.: Reseach Information and publication Service, NSRP 0140,1982.

ERIKSON, J. R. et al. Basic & Functional Design GrouP.TriP Report to Ishikawajima-Harima Heavy Industires Co., Ltd. Bath, Maine, 1982

SMITH, G. A. "National Shipbuilding Research Program; British Shipbuilders Technology Development Report No. 16/82, Study Tour to Japan, Oct. 1982; Summary Report, Part I." Bellevue, WA, 1983.

SPILLANE, J. NTEL. "Can We Expect the Shipbuilder/Design Agent Relationship to Produce Inexpensive High Productivity Ships?" Paper presented at the SPC/IREAPS Technical Symposium, 24 August 1983.

SNAITH, GEORGE. "Describing Key Changes in Production in the Small Ship Sector."' British Shipbuilders, 1983 (Typewritten.)

U.S. Department of Tranpsortation. Maritime Administration. The National Shipbuilding Research Program, Design for Zone Outfitting. Ann Arbor, MI.: Research Infomation and Publication Service, NSRP 0179, 1983.

VANDER SCHAAF, J. R. et. al. Detail Design Groin Report of Trip to Ishikawaima.Harima Heavy Industries Co., Lts . Bath, Maine, 1982;

SNAHE/Ship Production Committee. Minutes of the March 23, 24 and 25, 1982 Meeting of the Design/Production Intimation Panel. SP-4, by F.B. Barham, Jr., SP-4 Program Manager, Newport Nets Shipbuilding, VA, 1982.

U.S. Department of Transportation. Maritime Administration. The Shipbuilding Technology Transfer Program, Engineering and Desire: Executive summary. Ann Arbor, MI,: Research Information and Publication Service, NSRP 0022, 1980.

U.S. Department of Transportation. Maritime Administration. The Shipbuilding Technology Transfer Program, Levingston and IHI. Vol. I: Final Report Engineering and Design. Ann Arbor, MI.: Research Information and Publication Service, NSRP 0023, 1980.

Ishilcawajima-Harima Heavy Industries Co., Ltd. "functional Flow Chart of Ship's Engineering and Design." Tokyo, 1979.

Ishikawajima-Harima Heavy Industries Co., Ltd. "Hull Planning to Facilitate Outfitting." Tokyo (Draft).

JAQUITH, P. E. "1982 Trip to IHI Notes. "Bath, Maine, 1982. (Hand and Typewritten.

KUROSE, H. "IHI Harine Technology Inc. Presentation to Human Resources Subcommittee on Navy Shipbuilding Technology Conference." 1982 (Typewritten).

JAQUITH, P. E. "Introduction to Japanese Shipubilding Technology." 1979 (Typewritten).

U.S. Department of Transportation. Maritime Administration. The National Shipbuilding Research Program, Integrated Hull Construction. Outfitting and Painting (IHOP). Ann Arbor, MI.: Research Information and Publication Service, NSRP 0169, 1983.

Work Group on Integration of Engineering and Production for the Committee on U.S. Shipbuilding Technology, Marine Board, Commission on Engineering and Technical Systems National Research Council. A working paper on, "Integration of Engineering and Production Functions to Support Zone-Oriented Design and Construction of Ships." 1984 (Typewritten).

U.S. Department of Transportation. Maritime Administration. The National Shipbuilding Research Program, Japanese Technology That Could Improve U.S. shipbuilding Productivity. Ann Arbor, MI.: Research Information and Publication Service, NSRP 0109, 1980.

Ishikawajima-Harinm Heavy Industries Co., Ltd. "Logic and Principles of Outfitting Total System in Kure Shipyard, IHI: Concept of Outfit Planning." Tokyo, 1977.

Ishikawajima-Harima Heavy Industries Co., Ltd. "Logic and Principles of outfitting Total System in Kure Shipyard, IHI: Design." Tokyo, 1977.

Ishikawajima-Harima Heavy Industries Co., Ltd. "Outfit Design to Facilitate" Zone Outfitting Method." Tokyo (Typewritten).

U.S. Department of Commerce. Maritime Administration. The National Shipbuilding Research Program, Outfit Planning. Ann Arbor, MI.: Research Information and Publication Service, NSRP 0096, 1979.

Ishikawajima-Harima Heavy Industries Co., Ltd. l "Outline of Design Systems in Kure Shipyard." Tokyo, 1980 (Typewritten).

Mitsui Engineering and Shipbuilding Co., Lts. "Outline of Management, Design and Production Technology in Mitsui Tamano Works (Shipbuilding Division) (Typewritten).

Ishikawajima-Harima Heavy Industries Co., Ltd. "Outline of IHI Outfitting system. "Tokyo, 1977.

VAUGHAN, ROGER. "Productivity in Shipbuilding.: Paper presented at the North-East Institution of Engineers and Shipbuilders, Newcastle upon Tyne, 1983.

U.S. Department of Transportation. Haritime Administration. The National Shipbuilding Research Program, Product Work Breakdown Structure- - Revised. Ann Arbor, MI.: Research Information and Publication Service, NSRP 0164, 1982.

Ishikawajima-Harima Heavy Industries Co., Ltd. "Ship Design: No 1 Ships Design Department (Aioi)." Tokyo, 1982 (Typewritten).

U.S. Department of Transportation. Naritime Administration. The National Shipbuilding Research Program. 1985 Ship Production *SYIRP*osium. Vol. I & 11. Long Beach CA, 1985.

U.S. Department of Transportation. Haritime Administration. The National Shipbuilding Research Program. Manufacturing Technology for Shipbuilding-Project Condensation. Ann Arbor, MI, 1986.

u.s. Department of Transportation. Haritime Administration. The National Shipbuilding Research Program. Engineering for Ship Production: A Textbook. Ann Arbor, MZ, 1986.

U.S. Department of Transportation. Maritime Administration. The National Shipbuilding Research Program. Flexible Production Scheduling System. Bellevue, WA, 1986.

U.S. Department of Transportation. Maritime Administration, U.S. Navy and Newport News Shipbuilding. The National Shipbuilding Research Program. Implementation of Advanced Technology in the Shipbuilding Industry: Workshop. Ann Arbor, MI, August 5,6,7, 1986.

STERNS, ANTHONY A. "Shop and Zone Administrative and Mangement: The Transition to Zone Outfitting in Repair and Overhaul at Puget Sound Naval Shipyard." Paper presented at the University of Michigan, August 1986.

STERNS, ANTHONY A. "Zone Outfitting in Repair and Overhaul: The Strggle to Modernize at Puget Sound Naval Shipyard." Paper presented at the University of Michigan, August 1985.

CONNER, PAtrICK E. Organization: Theory and Design. Science Research Associates Incorporated; Chicago, 1980.

U.S. Department of Transportation. Maritime Administration. The National Shipbuilding Research Program. Paper presented by F. Shel Kjerulf, *Unit Work Guide for Zone Outfitting in Repair and Overhaul." Hampton Roads, Virginia, 1986

MOEN, DENNIS. "Application of Zone Logic and Outfit Planning Concepts to Overhaul, Moderization and Repair of U.S. Navy Ships." Journal of Ship Production. Vol. I, Number 4 (November 1985): 238-248.

LAMB, THOMAS. "Engineering Management for Zone Construction of Ships." Journal of Ship Production, Vol. 1, Number 4 (November 1985): 266-287.

GALBRAITH, JAY. Designing Complex Organization. Addison-Wesley. 1973.

WATERMAN, ROBERT H, PETERS, THONAS J. and PHILLIPS, JULIEM R. "Structure is Not Organization." Foundation for the School of Business at. Indiana University; reprint ed.; Bloomington, Indiana, 1980.

GREINER, LARRY E. "Evolution and Revolution as Organizations Grow." Harvard Business Review (July-August 1972): 37-46.

Harvard Business School. A Note on Structure (1-482-058). Boston, Mass., Seminar Handout.

PASCARELLA, PERRY. "Resistance to Change." Industry Week (JulY 27, 1987): 45-47.

U.S. Department of Transportation. Maritime Administration. The National Shipbuilding Research Program. "Design for Production Manual Volumes I. 11 and III. December 1985.

APPENDIX

COMMENTS RECEIVED

AND

RESPONSES

COMMENTS RECEIVED FROM B. L. SKEENS

JOHN J. MCMULLEN ASSOICATES INC.

The author is to be complimented on providing an overview and thought provoking treatise on a timely subject. My comments and questions are offered with the hope that they can serve as a catalyst to generate additional discussion or provide clarification.

1. Both the Executive Summary and the Introduction state that foreign yards organizations were included in the study. Very little in way of hard data is provided on results and responses - what questions were asked - no comparison of foreign to domestic yards is offered. No evaluation of the applicability of foreign yard provided data to domestic yard situations has been note (i.e. - Do any of the responding foreign yards fall in what is later defined as Type A or Type B yards?).

2. In “Description of Organizational Types”, Page 5 - Based on discussions and conclusions of the report, it. would seem more appropriate to divide yards into two major categories (i.e. (1) Large Ship New Construction Yards and (2) Small Boat Building/Repair and Overhaul Yards) with five categories noted here used as subsets of these.

3. In "Description of Organizational Types:, Page 6 - The discussion notes two questions asked (top of page and bottom of page). They appear to be essentially the same. If not, what were the responses and how did they compare within the same shipyard response?

4. On Page 8 - At the bottom of the page there are statements relative to what "the large shipyards" are going to do relative to planning - are these statements supported by shipyard responses?

5. Also on Page 8 - It is stated that Figures 2, 3 and 4 depict typical organizations - Are these proposed? suggested? or actual based on data received from responding yards.?

6. On Page 12 - Statement is made that "no pure product organizations were found". Why not? - IS a "pure product" organization not good? - not possible? Has it been tried and rejected? Is the IHOP organization a result of **attempts at "pure product" methodology?**

7 . The last sentence on Page 14. If, as this statement would suggest. this is the primary reason for the "popularity" of matrix organizations the point should be developed further. What are the requirements that make matrix organizations attractive? What are the draw backs? Do any foreign yards use this type?

8. Statement at top of Page 18 - "For a repair yard to control work on a zone basis, all of the design ----- converted to zone drawings. This task is both costly and time consuming." Is this conclusion based on hard data obtained from shipyard responses to the questionnaire? Papers by Dennis Moen (Journal of Ship Production, November 1985). by Shel Kjerulf (1986 Ship Production Symposium) and by Carl T. **Braun and James H. Shoemaker (SNAME Hampton Roads Section,** April 1987) all reach just the opposite conclusion.

9. For clarity the proposed organization charts Figures 9, 12 and 13 should be annotated to the five types of shipyards described earlier.

10. Figure 10, Sheet 1 - This is the first mention in the report of what we feel is one of the most important steps in the design/engineering process - the Zone (or Transition) Design. Although, it is stated on Page 24 that "the

outfit groups will be responsible for controlling interference within the zones", it is our feeling that this phase of the design is treated far too lightly. It is our experience that this phase, utilizing the proper personnel resources can "make or break's a design project. Properly managed and controlled this phase will (1) reduce the need for the type of personnel redundancies noted on Page 20, (2) reduce the number of interfaces with the functional design groups, (3) allow the production designer to apply full efforts to the production process with minimum regard for interferences. and (4) reduce installation Problems by providing a focal point for resolution of interferences.

11. On Page 33 it is noted that product design phase for nuclear work remain the responsibility of Product Design Group. In theory this is preferred, in actual practice it is doubtful that the controlling agencies would allow this arrangement or at best would make it difficult.

12. On Page 34 the statement is made that "to educate a design agent to produce the specific products and in the format required" would be "costly in both time and money". Our company has been very successful in meeting the needs an requirements for several shipbuilders which have been involved in the new methodology to varying degrees. Once

the concept is grasped, moving from one shipyard to another is simply a matter of understanding the differences in how the methodology is applied and the specific content of data required on the documentation.

13. On Pages 35 through 38 - It is not clearly stated which of the ‘proposed” organizations is being discussed - the opening paragraph of this section should identify where this section is headed. Does the section apply to all shipyards?

14. Top of Page 39, second sentence - The project covers organizations, not development of zone drawings. The study evaluated existing organization and how these could be structured to more efficiently produce design documentation oriented to zone outfitting methodologies.

15. On Page 40 under the product oriented design department it should be mentioned that design interference ontrol is a major responsibility.

16. The writer does not mention how the recommended organization will interface with other shipyard operations. If it was considered it should be noted as not being a significant factor or as readily adaptable. How, or where in the organization. are such functions as Testing, Design **Quality** Assurance. Configuration Management- Data Management R&M Human Engineering. SafetY. Access Control, procurement Support. etc. incorporated in the design and engineering process.

RESPONSE TO MR. B. L. SKEENS

1. Very little data was received from foreign yards. Some information was obtained from WARTSILLA and IHI which was factored into the report.

2. We agree that the yards could have been divided into two major categories and subsets used to cover all five types.

3. In the description of the organizational types the first question was intended to cover the entire shipyard while the second was intended to cover the relationship between design and production.

4. The-responses of the large shipyards indicate that many are considering decentralizing their planning fuction.

5. The typical organizations shown in Figures 2, 3 and 4 were developed from the data received from the shipyards.

6. As stated, we did not find any "pure product organization". It is probable that such an organization is not feasible in a shipyard engineering department that must produce a functional design before it can be redefined as product design.

7. As"indicated in the next section. the matrix type organization attempts to take advantage of both functional and product organization. A primary disadvantage of this type of organization is that it is often difficult to assess responsibility.

8. .I don't believe that anybody would disagree that it is time consuming and costly to change detail system drawings to zone drawings. It might, however. Prove to be cost effective if adequate savings are realized by the production trades.

9. It is intended that Figure 9 be the basic organization. Variations on the basic theme can be developed to suit specific situations, these Figures 12 and 13 are intended to be possible variations.

10. Transition design or changing from functional drawings to detail product drawings is an important step in the design process. Organizationally, this is performed by the Product Design Department as described on Page 24. We would also agree that interference control is a very important phase of the design process; however, we are looking at the organization not the process.

11. We were attempting to develop the most efficient design organization to support zone construction. If the customer demands something different - so be it.

12. The differences in how the methodology is applied and the specific content of data required on documentation for detailed work packages to support zone production in different shipyards is very extensive. We believe that most shipyards would agree that to assure that the design agent provides exactly what their production trades require is a time consuming task.

13. The section in transition was intended to offer suggestions on how and when current shipyard organizations could change to the new type of organization.

14. The point is well taken. The sentence has been changed to read, "The change this research project. studied was how engineering and planning departments could be reorganized to produce the system drawings and the detailed zone drawings required by production."

15. Interference control is a major responsibility and we consider that a product oriented design department will be most efficient in performing this function.

16. Our primary consideration was the interface between design and production to support zone construction concepts. Other areas were given little. if anY, consideration.

COMMENTS RECEIVED FROM JOSEPH GETZ

BETHLEHEM STEEL CORPORATION

1. Page 7 - The sentence on organizational charts needs to be cleaned up.

2. It is my gut opinion that the matrix organization will work only in the largest of organizations where people resources are the greatest and minimal orgnaizational effect takes place by the shifting of a "people" resource from one program to another. I assume it would work well for BIW'S and NNS'S of the world.

3. The thinking process that will promote coordination between disciplines in a product oriented design group during the initial design phase ill require a significant Period of time to become established.

4. Page 18 - The addition of an example or figure would be helpful to show that the line of authority to the decision makers are shorter in a product oriented design organization.

5. The matrix organization has some drawbacks such as lines of authority. This may deserve some expansion.

6. A product based organization for types D and E yards are like shooting a mouse with an elephant gun. It is my opinion that Types D and E yards should remain functional in organization.

7. For overhaul yards. why not use the shiP itself as the needed zone documentation, i.e., ship check and forget the need for zone drawings?

8. I agree that a centralized planning group would establish zone breakdown. unit boundaries, etc.; however, it is the detail design group that develops working drawings for production.

9. The combined engineering and planning organization shown makes no mention of transition design stage as indicated in the Design for Production Manual, Volume 2, Section 2.2.4.

10. Page 23 - The proposal.team appears to be the same as the Build" Strategy Team in the Design for Production Manual, Volume 1. Section 1.2.4.

11. Page 25 - ''That each section will have **adequate capability in each discipline" is a good idea on paper, but always results in a weak area in each zone.**

12. The free interchange of Personnel requires large personnel numbers which is good for large yards only.

13. Page 30 - As it being suggested that planning and engineering personnel be interchangeable? (Blasphemy!)

14. Why are standards not as important relatively for small yards as for large yards?

15. Problem Areas - I don't particularly like the use of engineering and design nomenclature to separate functional design and product design. I suggest using a more accepted nomenclature used by our industry.

16 The alternative to educating the design agent as to the specific products required by the shipyard would be to furnish a large management group assigned to the design agent and well versed in all design, planning, and production aspects of their shipyard.

17. I noted with great interest the extensive bibliography attached to this report and I found one item conspicuous in its absence. The item missed is the" Design for Production Manual. Volume 2, part 4 is entirely devoted to the planning function in response to changes taking place in the design function as a result of emphasis in zone or product design. I would like to know if you have any comments on this section after you review it.

RESPONSE TO MR. J. GETZ

1. In the final draft we have changed the word include to. provide and the word contrast-to concepts.

2. We did not recommend that a matrix type organization should be established in any shipyard.

3. This is somewhat a matter of opinion. We consider that coordination between disciplines in a product oriented design group will take place easier and quicker then in a functionally oriented design group.

4. In the suggested organization chart (Figure 9), the decision maker is assumed to be the Director of Product .Design, thus a very short line of authority.

5. One of the major drawbacks to the matrix organization is the divided lines of authority. The question of who is the "boss" can get to be a problem.

6. This is a matter of opinion. We consider that there is potential efficiency to be achieved for any yard if the design departments are organized to better serve the production trades.

7. Using the ship itself for the zone documentations might work for commercial repairs, but would not satisfy the U.S. Navy's requirements for updated plans.

8. In the past many shipyards used the centralized planning groups to convert detailed functional or system drawings to products required for zone production. In our proposed organization this function would be the responsibility of the Product Design Group.

9. As indicated in Figure 10, transition design is performed by the Product Design Group.

10. The proposal team would be very similar to the Build-Stra.tegy Team: however, they would have the additional responsibility to prepare the technical write up for the proposal.

11. It is hoped that the weak areas could be supplemented by transfer of personnel as required. Thus, if the piping in one zone was nearly complete, some the the expertise could be transferred to another zone that was weak in piping.

12. We believe that the free interchange of personnel would be even be more beneficial to the small yards where resources are limited.

13. It was not intended-to suggest that planning and engineering personnel be interchangable--only personnel be' transferredto where their specific talent was most needed.

14. Standards are a means of communication between the designer and production. It is considered that the smaller yard would have closer communication without the necessity for large numbers of standards.

15. Engineering and Design used in the context of this paper was intended to be generic. To be consistent with the title we should have used Engineering and Planning Organization.

16. We have added the Design for Production Manual to the bibliography. It was an oversight on our part. ~

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